Evaluation and Inter-comparison of Open Road Line Source Models currently being used in the Nordic Countries: A NORPAC Project

Janne Berger[A], Sam-Erik Walker[A], Bruce Denby[A], Per Løfstrøm[B], Matthias Ketzel[B], Ruwim Berkowicz[B]

A: Norwegian Institute for Air Research (NILU) P.O. BOX 100, 2027 Kjeller, Norway; jbe@nilu.no

B: National Environmental Research Institute (NERI)

Introduction

In order to evaluate and develop dispersion models, comparisons between different models and between different datasets are crucial. Described here are model results from two open road line source models applied to two different datasets from measurement campaigns at open roads near Copenhagen and Oslo. The preliminary results presented here represent the first stage, covering Norwegian and Danish models and datasets. NO_X is used in this inter-comparison as its emissions are better defined than for other compounds.

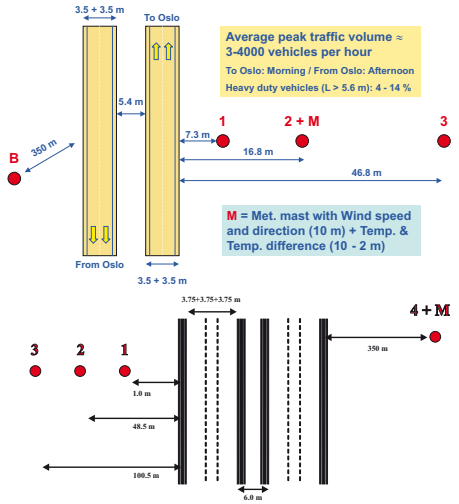

Figure 1. *Sketches of the Norwegian (top) and the Danish (bottom) site. Only results are shown for station 3 for the Norwegian dataset and for station 2 for the Danish dataset.*

Datasets and Models

Both the datasets used were made during intensive campaigns near highways where three air quality stations were positioned at different distances from the road in the dominant downwind direction (figure 1). In this paper results from the inter-comparison are shown for just one station from each of the datasets. Both these stations are positioned approximately 50 m from the highway.

For the inter-comparison we have used the OML model[1,2] and the WORM model[4], developed at the NERI in Denmark and NILU in Norway, respectively. Both are atmospheric dispersion models, where it is assumed that the dispersion of a plume develops in a steady state Gaussian manner. The OML model has traffic produced turbulence (TPT) integrated, taking into account the initial dispersion caused by the vehicles. Traffic turbulence in WORM is modelled by defining initial size of the plume σ_{z0} and $\sigma_{y0} = 2\sigma_{z0}^{3}$.

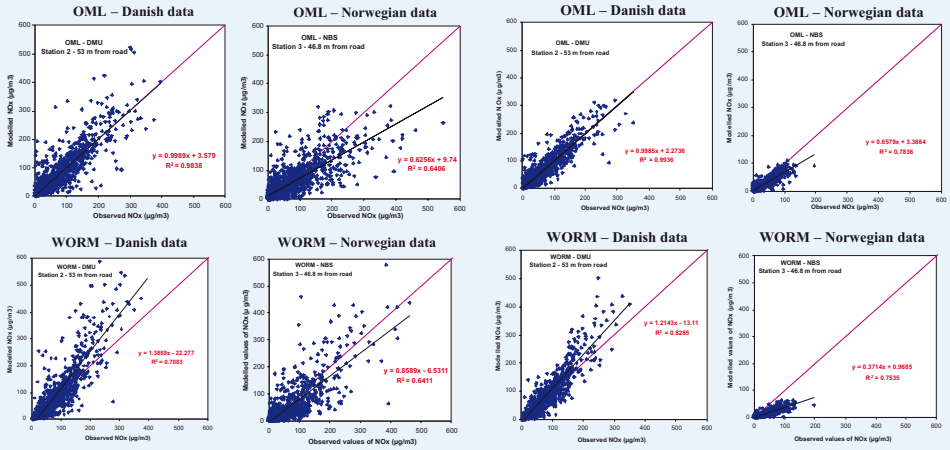

Figure 2. Comparison between modelled and measured NO_X concentrations. For the OML model all wind directions, all wind speeds are included. For the WORM model all wind directions and wind speeds above 0.5 ms^{-1} are included.

Figure 3. Comparison between modelled and measured NO_X concentrations. Only data for which the wind speed are above above 2 ms^{-1} are included. All wind directions are included.

Results and Discussion

Figure 2 and 3 show scatter plots of modelled and observed concentrations of NO_X for OML and WORM applied to both datasets with background excluded. In figure 2 all wind directions and wind speeds are included, while in figure 3 only data for which the wind speeds (u) are above 2 ms^{-1} are selected. Both models perform well on the Danish data, except for a slight overestimation by WORM. Both models underestimate the Norwegian data significantly. The selection of data (i.e. $u > 2$ ms^{-1}) in figure 3 has more effect on the WORM model results, as TPT plays a greater role at lower wind speeds. The results are further summarised below in table 1. Also included in the table are model runs for a third selection of data, i.e. data for which $u > 2$ ms^{-1}, and for which wind directions (θ) are perpendicular to the road ±30°.

Table 1. Fractional bias (top) and correlation (bottom) for OML and WORM applied to the Danish and Norwegian datasets for all the three alternatives.

Fractional bias (FB)

Model	OML	OML	WORM	WORM
Dataset	Danish data	Norwegian data	Danish data	Norwegian data
All data	0.05	-0.24	0.12*	-0.30*
u > 2 ms^{-1}	0.09	-0.28	0.05	-0.86
u > 2 ms^{-1}, θ ⊥ road ± 30°	0.01	-0.11	0.09	-0.70

Correlation coefficient R^2

Model	OML	OML	WORM	WORM
Dataset	Danish data	Norwegian data	Danish data	Norwegian data
All data	0.98	0.64	0.71*	0.64*
u > 2 ms^{-1}	0.99	0.78	0.83	0.75
u > 2 ms^{-1}, θ ⊥ road ± 30°	0.87	0.81	0.85	0.85

* For the WORM model all wind directions and wind speeds above 0.5 m/s are included.

Conclusion

In general it can be seen that both models perform quite well on the Danish data set with the WORM model overestimating the concentrations. Both models underestimate concentrations for the Norwegian dataset. The same tendencies occur for both the filtered and unfiltered datasets. There does not seem to be a significant degradation in the results when all wind directions are included in the analysis, indicating that both models perform well for all wind directions.

The major difference that should separate the models is the inclusion of TPT. The Danish measurements were carried out on a much more trafficked road than the Norwegian measurements, and the average traffic speed at the Danish site was also higher. As a result the TPT should be significantly higher at the Danish site. Hence, since the WORM model does not take into account the TPT, as OML does, we expect the WORM model to produce higher concentrations at the Danish site relative to those at the Norwegian site. Further work will be carried out in this study to include the Finnish and Swedish models and datasets.

References

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